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1990 Pittsburgh Conference
program Page 49

DECEMBER 4, 1989

CHEMICAL & ENGINEERING

NEWS

China

Chemical industry developing
to match a changing society
Page 7

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News of the Week

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Science/Technology

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Cover: Photo by C&EN's Joseph Haggin

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News Focus

Recent ACHEMASIA '89 meeting, hosted for the first time by China, featured variety of exhibits and technoeconomic lectures as well as discussions on past, present, and future of Chinese chemical industry. **Page 7**

Chemical & Engineering News

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LETTERS

Credentialing program

SIR: In response to the letter from Michael K. W. Li (C&EN, Oct. 16, page 4) concerning the usefulness of a professional title for consultant chemists and others, I suggest he investigate the credentialing program of the National Certification Commission in Chemistry & Chemical Engineering. As sponsored by the American Institute of Chemists, it confers the status of Certified Professional Chemist and/or Certified Chemical Engineer to those who qualify.

Both titles have been accepted by the courts as to the credibility of expert witnesses and have won recognition elsewhere by consultants' clients and by others. Applications for the 1990 program are now available.

David A. H. Roethel
Executive Director, National
Certification Commission in
Chemistry & Chemical Engineering
Bethesda, Md.

Alar controversy

SIR: For some time, I have hesitated to address you on matters of publication policy. But now, when the National Academy of Sciences recommends that federal policies be reversed which, for four decades, have focused on increasing the productivity of crop and livestock farms through heavy use of pesticides, drugs, and synthetic fertilizers, I must let you know about the reservations I have when it comes to Ann M. Thayer's article, "Alar Controversy Mirrors Differences in Risk Perception" (C&EN, Aug. 28, page 7). Although I must compliment her on her perceptive treatment of the subject, I wish she had looked at it from a broader perspective.

In the first paragraph of her article, Thayer lets it be known that "the debate was rife with charges that the public and media overreacted, the government underreacted, and interest groups and industry misled the public." Thereby she identified the five actors in this dramatic situation: The public, the media, the government (Environmental Protection Agency), the interest groups, and Uniroyal Chemical Co., the industrial producer of Alar.

She did not even mention the most important and objective actor—the scientific community. It was represented by Bruce N. Ames, chairman of the department of biochemistry, director of the National Institute of Environmental Health Sciences Center at the University of California, Berkeley, and a member of the National Academy of Sciences.

The important scientific contribution of Ames has been the discovery that many of our vegetables contain nature's pesticides—for example, natural chemicals that cause cancer in rats or mice and that are present in enormously higher concentrations than the industrial chemicals present in the pesticide residues in plant foods. It is for that reason that his estimate for the number of cases of cancer or birth defects caused by man-made pesticide residues in food or water pollution—usually at levels hundreds of thousands or millions of times below that given to rats or mice—is close to zero.

The debate began in February when the Natural Resources Defense Council (NRDC), an activist environmental group, released a report charging that a by-product of Alar is an animal carcinogen that poses an imminent hazard to humans, particularly children. Ames responded and declared in the *Los Angeles Times*, Feb. 27, 1989, that the Food & Drug Administration and EPA are much more competent in doing a good job of protecting our food supply from carcinogenic contaminants than the activist lawyers with NRDC who spend their time wooing the media with scientifically unfounded claims about the dangers of pesticides, but who have never assembled a knowledgeable board of scientific advisers.

There followed the publication of two letters in the May 19, 1989, issue of *Science*: Under the title "Alar in Apples," Edward Groth III of the Consumers Union of the United States Inc. makes his position quite clear. "The scientific facts (estimates of how big the risk is, with all the inherent uncertainties) are just part of what the public knows about Alar. The policy choices—both the personal and public kind—depend on far more than facts. However big a risk may be, whether it is acceptable or not is a value judgment and is heavily influenced by moral dimensions of the risk."

Ames, in collaboration with Lois Swirsky Gold, writes under the title "Pesticides, Risk, and Applesauce." In his concluding paragraph he states: "Regulation of low-dose exposures to chemicals, based on animal cancer tests, may not result in significant reduction of human cancer, because we are exposed to millions of different chemicals—almost all natural—and it is not feasible to test all of them. Most exposures, with the exception of some occupational, medical, or natural pesticide exposures, are at low doses. The selection of chemicals to test, a critical issue, should reflect human exposures that are high doses relative to their toxic doses

China's Chemical Industry Is Focus of ACHEMASIA '89

Joint West German-Chinese effort—ACHEMASIA '89—brought chemical engineers and biotechnologists to Beijing for exhibits and technoeconomic lectures as well as discussions of status of China's chemical industry

Joseph Hagglin, C&EN Chicago

The Chinese chemical industry is simultaneously old and new. Development of gunpowder, paper, and alcoholic beverages began centuries ago, but the modern chemical industry dates only from the early 1980s.

In between, chemical production was highly localized, typified by an early lead-chamber sulfuric acid plant operating in Tianjin in 1876. Other early plants made such basic products as soda ash, synthetic ammonia, nitric acid and explosives, and a few organic chemicals from coal tar.

Despite a long tradition of science that may be venerable and comforting, China faces immense challenges in providing for a modern, constantly changing society in excess of a billion people. In short, what China needs is a large and modern chemical industry that can provide and ensure future stability and a higher quality of life. The Chinese know this better than anyone, and, for at least the past 13 years, they have been progressing rapidly, if not always steadily, toward that end.

Evidence of such industrial progress came this fall at an exhibition and congress held in Beijing. A joint West German-Chinese effort called ACHEMASIA '89, the international meeting on chemical engineering and biotechnology occurred as planned, although it had been threatened with cancellation as a protest against the killings of demonstrators at Tiananmen Square early this summer by the Chinese government.

Technoeconomic lectures by industry officials at the ACHEMASIA

congress drew a profile of the Chinese chemical industry and the changes it is undergoing. An overview of the more recent development of the industry was presented by Chen Jianyuan, chief engineer of China's Ministry of Chemical Industry.

Several state ministries and corporations manage China's chemical industry. The managerial structure is constantly changing, but control at present is manifested through four major organizations: the Ministry of Chemical Industry, China Petroleum Corp. (SINOPEC), the China State Pharmaceutic Administration, and the Ministry of Light Industry. The division of responsibility between these organizations is not rigid, and occasional ad hoc arrangements are made between them for particular purposes. For ex-



Flags decorate entrance to ACHEMASIA '89 exhibition hall

C&EN staff photo

Four government organizations manage Chinese chemical industry

Ministry of Chemical Industry

- Fertilizers and agrochemicals (such as ammonia, pesticides)
- Basic chemicals (including sulfuric acid, soda ash, caustic soda)
- Coal chemicals (including calcium carbide, PVC, methanol)
- Fine chemicals (such as coatings, dyes, reagents, adhesives)
- Rubber products (such as tires, belts, hoses)
- Polymers (including polyolefins, acrylics, fluoropolymers)
- Special chemical ores
- Miscellaneous

China Petrochemical Corp. (SINOPEC)

- Petroleum refineries within China
- Petrochemicals (ethylene and derivatives, most organics)

China State Pharmaceutical Administration

Ministry of Light Industry

- Plastics processing, fabrication, and the like (mostly consumer products)
- Consumer specialties (such as detergents, cosmetics)
- Paper, leather, and miscellaneous items

Source: Chinese Ministry of Chemical Industry

ample, says Chen, coal tar chemicals are usually produced as by-products of steel making, thus they are usually managed by the Ministry of Metallurgical Industry.

According to Chen, in 1949, the total production of chemicals and related products in China was valued at about \$45.7 million. In 1988, the gross value of chemicals and related products had grown to \$18 billion. Most of production is in nonpetrochemical products. The progress chalked up by the industry is attributed to the success of the series of government-devised five-year economic plans that began in 1953.

Between 1953 and 1957, three state-owned chemical corporations were organized by the Ministry of Heavy Industry. Jilian Chemical Corp. made synthetic ammonia, nitric acid, ammonium nitrate, methanol, acetic acid, and other products using coal and coal tar as raw materials. Lanchow Chemical Corp. made butadiene-styrene rubber, butadiene-acrylonitrile rubber, polystyrene resins, and nitrogen fertilizers. Taiyuan Chemical Corp. produced insecticides, pesticides and agrochemicals, caustic soda, chlorine, nitrogen fertilizers, sulfa drugs, and vitamins. Another pharmaceutical plant began making antibiotics about the same time. Between 1958 and 1965, additional chemical plants began production of photographic products, inorganic chemicals, vinyl materials, polyamide fibers, polyvinyl chloride resins, and other plastics.

Development of the chemical industry, according to Chen, experienced some severe setbacks during the Cultural Revolution, which marked the decade ending in about 1976. Gross output dropped more than 10%. However, a number of small ammonia plants were built, and one naphtha cracking unit was placed

in service. Most of these units were purchased from Japan and the U.S.

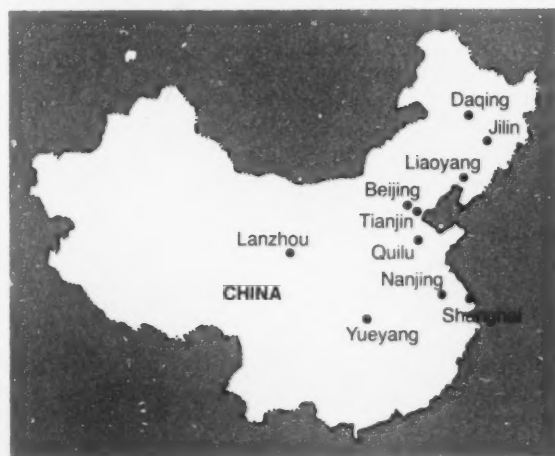
The government, Chen says, is also encouraging development of the petrochemical industry in the expectation that oil reserves will be developed in the South China Sea and in Guangdong, Fujian, and Hainan provinces. The government projects ethylene production will reach 2 million metric tons per year in 1990 and 3 million metric tons per year by the end of the century.

Most of the immediate improvements in the Chinese chemical industry are being made with the aid of imported technology and equipment. However, Chen adds, China recognizes that it must develop its own technology and is intensifying industrial research and is rapidly augmenting university training for scientists and engineers. China's goal is to acquire long-term continuity in R&D activities for industry.

A more specific look at the petrochemical industry was provided by Zhang Shi, a professor at Shanghai Research Institute of Petrochemical Industry and a representative of SINOPEC. The industry traces its origin back to a decision of the central government in 1956 to enhance crude oil production. Basic developments were carried out in Shanghai, Beijing, and Shanyan. The first petrochemical units were built and operated in Shanghai and Lanzhou using refinery gas as a feedstock.

In 1959, imported technology permitted production of 35,000 metric tons per year of ethylene from heavy oil. The downstream products issuing from this base were low-density polyethylene, polypropylene, acrylonitrile, acrylic fibers, and polypropylene fibers. Most of the plants were small and aimed at satisfying local needs. This picture remained more or less fixed until another basic decision of the government in the early 1970s decreed the further importation of technology and a new capacity increase. By the end of 1988, the

Chinese petrochemical industry is concentrated in eastern provinces



industry had reached a plateau; any further change in the industry's growth will be dependent upon upcoming five-year plans.

Most petrochemical enterprises are operated by SINOPEC, which was organized by the government in 1983. In 1988, sales revenue for SINOPEC was about \$13.4 billion, with a net profit of \$4.25 billion. SINOPEC controls 94% of the national refinery capacity and 85% of ethylene capacity. Other state agencies control the remainder.

With the development of the Daqing oil field in 1960 and the Shengli oil field in 1965, the petrochemical industry had sufficient feedstocks available to operate.

The petrochemical industry in China began with the completion of an ethylene plant at Daqing in 1986. Two others—Qilu and Yangzi—went on stream in 1987. Another is now under construction in Shanghai. Each of the plants will produce about 300,000 metric tons per year. In subsequent years, other fields in Dagang, Fuyu, Jiangnan, and Liaohai contributed additional production, such that present refining capacity exceeds 7 million metric tons.

However, Zhang adds, distribution remains a problem. The original oil fields were seldom located close to refineries, which tended to be small and localized. Consequently, it was difficult or impossible to supply the appropriate feedstocks to all refineries. For reasons such as these, the petrochemical industry developed in a pattern determined by the availability of feedstock.

Before 1970, most of the plants for producing petrochemicals were the result of government R&D efforts being gradually extended to semiworks. The large manufacturing plants did not appear until the early 1970s. Then, imported technology was acquired for large-scale production of ethylene, polyethylene, polypropylene, ethylene glycol, polyesters, acrylonitrile, and other materials of commercial importance.

By 1980, China had contracted for four 300,000 ton-per-year ethylene plants and for corresponding downstream facilities. According to Zhang, all of these will be on stream by 1990. In addition to these, a smaller 115,000 ton-per-year plant was built at Jilin in 1982.

Despite the progress in acquiring chemical plants, Zhang says the industry's maximum production is still far short of demand, and imports have continued to rise apace. The problems have been somewhat inflamed by a sharp rise in ethylene prices in 1987.

The petrochemical industry is capital-intensive, a major reason, according to Zhang, for the strong emphasis on foreign joint ventures currently under way in China. Strong emphasis on foreign capital acquisition is likely to continue for the next several years, coupled with the maximum possible domestic development, to eventually reduce chemical imports to an acceptable level.

In light of China's enormous population, food production remains the first priority of the government. More than 100 cities in China have populations of more than 1 million, and there are several hyperintensively populated regions around such cities as

Some major petrochemical plants operating in China

Plant/location	Refinery capacity (thousands of metric tons)	Ethylene capacity	Principal products
Lanzhou Chemical Industry Co., Lanzhou	—	100	Rubber resin
Gaogao Petrochemical Co., Shanghai	4500	15	Resins, organic raw materials
Yanshan Petrochemical Co., Beijing	7000	300	Rubber resin
Shanghai General Petrochemical Works, Shanghai	2800	120 ^a	Fiber resin
Liaoyang Petrochemical Fiber Co., Liaoning Province	1500	73	Resin, fiber
Daqing General Petrochemical Works, Daqing	5000	300	Resin, organic raw materials
Qilu Petrochemical Co., Shandong Province	6000	300	Resin, organic raw materials
Yangzi Petrochemical Co., Nanjing	3000	300	Resin, organic raw materials
Jilin Chemical Industry Co., Jilin	2500	115	Organic raw materials
Yueyang General Petrochemical Works, Yueyang	—	—	Liquefied petroleum gas, organic raw materials
Tianjin Petrochemical Co., Tianjin	3500	—	Benzene-toluene-xylene, fiber

^a 300 under construction. Source: China Petrochemical Corp.

Ethylene production, capacity increase sharply

Thousands of metric tons	1988	1987	1986	1985	1984	1983
Ethylene (capacity)	960.0 (1620)	820.0 (1600)	695.3 (9800)	652.1 (680)	648.0 (680)	653.7 (680)
Plastics resin	986.8	730.0	1322.5	1232.7	1179.9	1121.0
Synthetic fibers and monomer	1420.4	1330.0	1904.3	1871.4	1382.4	957.3
Synthetic rubber	192.5	150.0	188.4	180.1	170.0	168.0

Source: China Petrochemical Corp.

Beijing, Shanghai, and Guangzhou (Canton). Nevertheless, about 80% of the Chinese population is still considered rural, and much of that population are farmers.

The problems of generating high enough food production rests in large measure on the success of fertilizer manufacture. The current situation in this industrial sector was put into perspective at the AICHEMASIA congress by Liang Zhifang, senior engineer at Shanghai Research Institute of Chemical Industry. She noted that China, with a quarter of the world's population, has only 7% of the arable land. Thus, increasing unit area production is highly important, and chemical fertilizers have been responsible for much of the success so far. This success, Liang adds, has not been achieved without some problems as well, but there seems to be no other course to follow than the ever larger use of chemical fertilizers.

China breaks new ground by hosting international science, technology meeting

If China can't come to the fair, take the fair to China! That seems to have been the philosophy behind ACHEMASIA '89, a joint effort between West Germany's Deutsche Gesellschaft für Chemisches Apparatewesen, Chemische Technik und Biotechnologie, or DECHEMA (German Society for Chemical Equipment, Chemical Technology & Biotechnology), and the Chemical Industry & Engineering Society of China, or CIESC.

ACHEMASIA '89—an international meeting on chemical engineering and biotechnology and the first of its kind in China—had been in preparation for several years. As the date for the event neared, it had been threatened with cancellation when China's repressive policies intensified following the events of early June in Tiananmen Square. However, the resolve of the organizers and participants to proceed was fortified by the nonrefundable investment required of the exhibitors, and the exhibition/congress was held as planned.

The main purpose of ACHEMASIA '89 was to make European, Japanese, and North American chemical engineering and biotechnological know-how more widely available in Asia. Asia's population growth begets economic growth. Supporting both will require the application of chemical engineering and biotechnology, much if not most of which will come from Europe, Japan, and North America.

In addition to DECHEMA and CIESC, other groups supporting ACHEMASIA included the Ministry of Chemical Industry of China, China's Chemical Plan-

ning Institute, China Petrochemical Corp., China International Trust & Investment Corp., the European Federation of Biotechnology, and the European Federation of Chemical Engineering.

Although there was some representation from Japan, the U.S., and the rest of Europe, the exhibition/congress, not surprisingly, was mainly a German "show." A total of 335 exhibitors manned the booths including 119 from China itself. The premeeting publicity suggested 40,000 visitors but observation indicated less than that number. There were also about 200 lectures and seminars, attended by about 1800 people.

Beijing was the organizers' choice as the location for ACHEMASIA '89 because of the economic and political stability demonstrated in China and other Asian countries and because of the recognized need for establishing long-term relations with potential partners and customers in China. The general format is that of the ACHEMA exhibition/congresses produced by DECHEMA in Frankfurt every three years. Since the organizers of the recent ACHEMASIA '89 intended to make the exhibition/congress the basis for continued development of professional and business contacts, the original decision was to hold an ACHEMASIA meeting every other year. That decision is now under review by the sponsors.

DECHEMA is a not-for-profit technical and scientific society established in 1926. Currently under managing director Dieter Behrens, it provides educational and informational products and

services and conducts research for its members. An integral part of the organization is the DECHEMA Institute, founded in 1961 by Karl Winnacker. The institute is staffed by about 80 people who perform research and conduct technical consultation for members.

The principal activity of DECHEMA, however, is the ACHEMA exhibition/congress. ACHEMA is an acronym for *Austellungs-Tagung für Chemisches Apparatewesen* (chemical engineering exhibition and congress). The first was held in 1920 before DECHEMA was formally organized and had 75 exhibitors. The most recent ACHEMA was in 1988 and had 2800 exhibitors and about 250,000 visitors.

At ACHEMASIA '89 there were four American representatives—Du Pont China Ltd. (Hong Kong), Mixing Equipment Co., Yellow Springs Instruments Inc., and Bepex Corp. The profusion of equipment and instruments usual for such events was not in evidence at the exhibition. Logistical problems of getting equipment in and out of China and indecision caused by the events of June discouraged elaborate displays. However, there was brisk business in technical literature and personal consultations. The most well-attended seminars were not the technoeconomic lectures, as the organizers had anticipated, but those dealing with hands-on laboratory and plant experience.

If ACHEMASIA '89 was primarily a German show in execution, it was primarily a Chinese show in reception. A lot of consultation remains to be done, to unite the twain.

In the 20 years prior to 1970, world grain output doubled. The United Nations Food & Agriculture Organization attributes between 40 and 70% of this increase to use of chemical fertilizers. The Chinese experience parallels these data. More than 163 million metric tons of grain were produced in 1952 using 78,000 tons of chemical fertilizers. The totals rose to more than 400 million metric tons of grain produced in 1987 using 20 million metric tons of fertilizers.

Before 1970, Liang says, most of the fertilizers produced in China were made using domestic technology, with small plants being widely dispersed to meet local needs. More than 1000 such plants were in production. During the 1970s, 13 large nitrogen fertilizer

plants and four large ammonia plants were imported. There are now more than 2000 fertilizer plants producing such chemicals as ammonium sulfate, ammonium nitrate, ammonium bicarbonate, urea, calcium cyanamide, aqua ammonia, anhydrous ammonia, ammonium chloride, single- and triplesuperphosphate, ammonium phosphates, potassium chloride, and numerous micronutrients. China is now the third largest producer of chemical fertilizers in the world following the U.S. and the U.S.S.R.

According to Liang, despite such a high level of fertilizer production, demand still exceeds supply. Imports still account for some supply, but the country intends to limit imports as soon as possible. The stated

goal of the Chinese government is to provide 400 kg of grain per person in China by the end of the century. The forecast is that chemical fertilizer demand will rise to about 30 million metric tons by the year 2000.

In the case of nitrogen fertilizers, Liang says the preferred production technology will be based on coal. This implies much development work on coal gasification and the generation of synthesis gas. Phosphate fertilizers will be based mostly on abundant phosphate ores from Yunnan and Guizhou provinces. Where possible, the production of phosphate fertilizers will be linked with the production of electricity. A major deficiency will be sulfur. China has limited sulfur deposits, and there is a good possibility that gypsum and other secondary sources of sulfur will be utilized. China is also poor in potassium sources. Domestic sources will be sought, but imports may become necessary.

In the immediate future, the construction of "built-in-China" fertilizer plants will become the norm. By the end of the century, new large-scale plants will be built by Chinese industry, and existing plants will be modernized as rapidly as possible.

Inorganic chemical production in China was described for the Congress by Sun Wei, an engineer at Tianjin Research Institute of Chemical Industry. The tonnage of inorganic chemicals ranks third behind fertilizer and sulfuric acid, with the largest manufacturing center being Shanghai. Inorganics are also third in dollar value behind fertilizers and rubber products, Sun says. In fact, this is one area in which China has enough material to export, sending out of the country about 400,000 metric tons per year of inorganics, especially barium chemicals and manganese products.

Inorganic chemical production, Sun notes, utilizes the most energy-efficient processes available. This can indicate the most modern technology or the most well

China produces variety of inorganic chemicals

	% total chemical production		% total chemical production
Arsenic compounds	0.3%	Magnesium compounds	2.5%
Barium compounds	2.0	Manganese compounds	2.8
Borides and borates	7.6	Molybdenum, titanium, vanadium, tungsten, zirconium	5.6
Bromides and bromates	2.5	Nitrates	4.3
Carbonates	5.3	Oxides	4.8
Chlorides and chlorates	11.5	Peroxides	1.0
Chromium compounds	3.6	Phosphorides and phosphates	8.9
Cyanides	3.8	Silicides and silicates	5.2
Fluorides	5.3	Sulfides and sulfates	9.8
Hydroxides	2.0	Other	10.2
Iodides and iodates	1.0	TOTAL	100.0%

Source: Tianjin Research Institute of Chemical Industry

established, depending on the circumstances. Included among newly imported technology are the Krebs electrolytic process for potassium chlorate from France, a new process for white carbon (a gray-colored industrial carbon useful as an absorbent) from the U.S., and several new processes for the production of granular barium and strontium carbonates from Japan.

The biggest problems plaguing the inorganic chemical industry are underutilization of mineral resources and correspondingly high consumption, the small scale of individual production units, the need for more reliable analytical methods to monitor product quality, and the strengthening of R&D in this often neglected area of production.

Other than fertilizers, highest priority in the new five-year plan of the Ministry of Chemical Industry appears to be given to pesticides for agriculture. This,

New minister of Chinese chemical industry faces number of thorny problems

Gu Xiulian, 52, has replaced Qin Zhongda as the Minister of the Chemical Industry for China. She had previously been vice minister for the State Economic Commission and governor of Jiangsu Province.

Gu's biggest problem will probably be reducing chemical imports, which are blamed for almost two thirds of China's trade deficit. She will also take on the perennial problem of general raw materials shortages that have plagued the country's chemical industry. Another thorny problem is generating more capital for industrial expansion, a problem the chemical industry has in common with every sector of the Chinese economy.

According to *China Daily*, a government newspaper, a new five-year plan is now being formulated by China and it is certain that the chemical industry will be sorely tested during its tenure. Gu won't speculate on the plan but has stated that the first priority of her administration will be to increase the quantity and quality of agricultural chemicals. These are crucial in the battle to feed in excess of 1.1 billion people. The emphasis on agricultural chemicals will probably be of particular benefit to Yunnan, Guizhou, and Hubei provinces, which contain the greatest reserves of nitrogen, phosphorus, and potassium raw materials.

The agricultural chemical industry

has already used about \$900 million in foreign loans for modernization and has been growing at the rate of about 18% per year for the past 40 years. The hope is that similar growth can be sustained. To this end, Gu is convening national conferences of the numerous research institutes to encourage greater efforts in developing foreign markets that might provide needed external income as well as new technology.

Gu also has been appointed chairman of the China-German Democratic Republic (East Germany) Economic, Technology & Trade Committee, which is seeking to expand trade in Eastern Europe.

Foreign investors in China should prepare for both pluses and minuses of doing business

Although the focus of AICHEMASIA '89 was the chemical industry of China, present and future, a more general look at the investment climate in China was provided by Yang Guanqi, vice president and senior engineer of China International Trust & Investment Corp. (CITIC).

According to Yang, China has been actively encouraging foreign investment in the country since 1979. The policies generally aim at opening up China for investment. There is no expectation by the government, he says, that the policies will change anytime soon.

The past 10 years are regarded as a successful economic period. China has opened a number of special economic zones, has established the guidelines for economic development of the coastal regions, and has set the priorities for foreign investment to favor export-oriented businesses. China has also improved the legal system with respect to foreign economic activity and has provided agencies to coordinate and advise the efforts of potential investors. Most important, the country has devoted considerable capital to the development of the necessary infrastructure to promote investment. Just how successful all this effort may be from the foreign viewpoint is debatable, but there can be little doubt that progress has been made and that more is needed.

The effects of the Chinese efforts to encourage investment are best seen in the results. According to Yang, at the end of 1988, there were about 15,900 foreign joint ventures in China, consisting of 8530 joint equity ventures, 6770 contractual joint ventures, and 594 wholly owned foreign enterprises. The total contracted foreign

investment in these ventures is more than \$25 billion, of which \$9 billion has already been absorbed. Yang says about 85% of these ventures display good operating records with appropriate returns on investment.

Yang characterizes China as the world's largest developing country and believes the country has need of much foreign investment that will aid import substitution—that is, the manufacture of products within China that will decrease the need for imports. Some of the areas of particular interest are energy, raw materials, and intermediate materials. Special priorities are assigned to 160 types of products in 30 categories, including agriculture, chemicals, metals, and minerals.

In considering investment in China, Yang advises the potential investor to give great thought to locating in the coastal areas of China. The intention is to encourage development from east to west in steps. There is also an implicit recognition that the coastal areas contain most of the amenities that most foreign investors would seek.

China has established four special economic zones and 14 coastal cities for special consideration in economic development. The largest is Hainan Province, an island off South China. These designated areas now contain about 80% of the present investment and about 160 million people.

Of particular interest to potential investors are the tax incentives that China provides. The list of incentives is complex and long, but one item that is of special interest is the reduction of the normal corporate income tax of 33% to 15% in the special economic areas and coastal cities and to 24% in other open economic areas. In addition, new ventures whose terms ex-

ceed 10 years are exempt from income tax for the first two years and receive a 50% reduction for the next three years.

Probably the most difficult thing for a foreign investor to do is to find a suitable Chinese partner for a joint venture. CITIC and other similar agencies help, but eventually it is a gamble. For most of the major projects involving chemical production, this is less of a problem. Usually company-to-company relations are well along before joint ventures are started.

In the drive to acquire foreign exchange credits, the Chinese have developed currency exchanges in great profusion. Tourists are required, for example, to utilize a special type of currency that trades at a special exchange rate. The government has established 39 currency exchanges in China. In 1988, the total turnover for these exchanges was cited by Yang as about \$6.3 billion, which accounted for about one third of the exchange that is represented by foreign joint ventures and about 18% of the total Chinese foreign exchange.

Anyone describing the problems of doing business in China encounters the inevitable horror stories, and even a few happy ones. In fact, the major difficulty in doing business in China is still the language barrier and the confidence that fluency in a foreign tongue provides. The Chinese have established numerous university-level institutes to train their citizens in foreign languages as well as other institutes for teaching foreigners the Chinese language. Although these institutes seem effective, few businessmen take advantage of them. Until they do, doing business in China will continue to generate horror stories.

like inorganics, is one of the unusual areas, in that it enjoys a substantial export market. Shang er Cai, director of the information research department of Shenyang Research Institute of Chemical Industry, says the estimated production of pesticides for 1989 will be about 200,000 metric tons. The fraction of this that will be exported is not specified.

Of special pesticide interest is research on natural compounds, which can be used either alone or in combination with the more familiar synthetic pesti-

cides. The Chinese agricultural zones, being primarily subtropical, are subject to a wide variety of pests often unknown elsewhere. Fungi are particular problems.

Whether addressing pesticides or petrochemicals, it is evident that the Chinese chemical industry as a whole has secured a toehold in attacking its problems. Based on the information given at AICHEMASIA '89, it seems China has both the resolve and the capacity to develop a modern chemical industry. □